

November 29, 2004

TO: G. Burke

FROM: E. C. Hampton

SUBJECT: **SE**Lenological and **EN**gineering Explorer (SELENE) launch
opportunities evaluationREFERENCE: Request from Albert F. Chang to perform a DSN load study to determine
the best of four launch opportunities for SELENE.

The Resource Analysis Team (RAT) has evaluated four launch opportunities for the SELENE Spacecraft utilizing the resources of the Deep Space Network (DSN) to determine the best of four opportunities for launch of the SELENE spacecraft. This evaluation focuses on the support SELENE should expect to receive if launch occurs on either of four proposed dates between November 2006 and October 2007 and the effect SELENE's requirements have on other projects' support and DSN resources.

Summary of Study

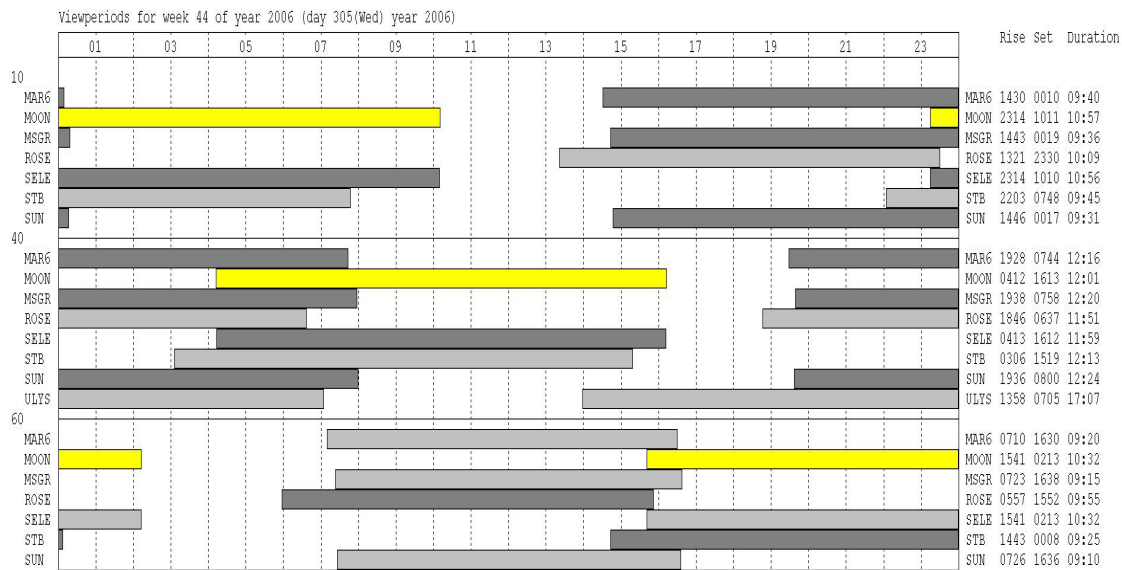
The analysis of the four proposed launch periods, November 1, 2006, February 1, 2007, July 1, 2007, and October 1, 2007 show that the best opportunity to support the SELENE launch is February 2007. The second best opportunity is July 2007. The Resource Analysis Team highly recommends that the SELENE launch and early orbit be scheduled in February of 2007 and recommend July 2007 as the second best launch opportunity for SELENE. It is also recommended that SELENE Project avoid scheduling the SELENE launch in November 2006 during the DSS-45 downtime, Mars Reconnaissance Orbiter (MRO) prime science, solar conjunction, and mapping phases, MESSENGER (MSGR) Venus approach and flyby, and Rosetta (ROSE) deep space maneuver and Mars swing-by activities. The proposed SELENE launch in October 2007 is also not recommended due to the new October 1 launch and 30 day commissioning phase for Kepler. The analysis shows that an October launch would be further impacted by the continued MRO mapping support, New Horizons (NHPC) checkout and Delta DOR phase, and ROSE Earth 2 swing-by phase. **See attached supporting data for Major Events and Major Antenna Downtime listings.**

Methodology

Analysis was accomplished using the Forecasting and Scheduling Tool for Earth-based Resources (FASTER) forecasting system and the current mission set database from the August 2004 Resource Allocation Review Board (RARB). The analysis assumes launch will occur on the first day of each launch period. Also, the analysis assumes that SELENE's view period is approximately the same as the Moon. View periods utilized in

this study are those for the Moon at 6 degrees elevation. View periods for SELENE were not available at the time of this study for the four proposed launch periods. **Figure 1** below shows the Moon view periods (in yellow) at 6 degree elevation and the overlap with various missions on the proposed launch day of November 1, 2006. DSN Signal Processing Centers (SPC) with visibility of the spacecraft and pass duration as defined by Moon view periods at each DSN SPC which represents DSS-24, DSS-34, and DSS-54.

Figure 1: November 1, 2006 View Period Overlap



Assumptions

November 1, 2006 Launch

- SELENE launch and initial acquisition will occur on the first day of launch window
- DSS-24 will be up and operational on time
- DSS-45 is down for Antenna controller Installation

February 1, 2007 Launch

- SELENE launch and initial acquisition will occur on the first day of launch window
- All 34Meter Antennas will be operational

July 1, 2007 Launch

- SELENE launch and initial acquisition will occur on the first day of launch window
- DSS-54 is down for X/X-Ka Band installation

October 1, 2007 Launch

- SELENE launch and initial acquisition will occur on the first day of launch window
- Kepler launch and initial acquisition will occur on October 1, DOY 274 with 30 days of continuous coverage for Commissioning

Requirements

SELENE requires continuous coverage on the 34M subnet for three weeks (21 days) beginning with launch and one 4-hour 26M support on launch day for initial acquisition.

Proposed Launch Opportunities during 2006 - 2007

November 1, 2006

Launch/Initial Acquisition	Nov. 1, 2006	Continuous support
Launch and Early Orbit	Nov. 2 – Nov. 22	Continuous 24 Hrs.

February 1, 2007

Launch/Initial Acquisition	Feb. 1, 2007	Continuous
Launch and Early Orbit	Feb. 2 – 22	Continuous 24 Hrs.

July 2, 2007

Launch/Initial Acquisition	July 2, 2007	Continuous
Launch and Early Orbit	July 3 – 23	Continuous 24 Hrs.

October 1, 2007

Launch/Initial Acquisition	Oct. 1, 2007	Continuous
Launch and Early Orbit	Oct. 2 – 22	Continuous 24 Hrs.

Initial Assessment

SELENE should expect to receive approximately 68 to 97 percent in November of 2006 and 73 to 86 percent in October 2007 of the requested time for launch and launch support. SELENE is projected to receive approximately 81 to 98 percent in February and 73 to 99 percent in July of 2007 of their requested time for launch and launch support. *See Figure 2 below.* The addition of SELENE requirements during all four periods studied causes a marked increase in 34BWG1 user unsupportable time, as shown in Figures 1-3 in the attached supporting data. Figure 3 shows the weekly forecast of requested versus supportable versus unsupportable time in hours for SELENE launch and 21 days of early orbit support for each proposed launch period.

Detailed Assessment

November 1, 2006 Launch and Initial Acquisition

SELENE can expect to receive 68 to 97 percent of their requested time for early orbit support on the 34BWG1 subnet and 100 percent of their requested support for initial acquisition on the 26M and 34BWG1 subnet on November 1, 2006. SELENE is requesting continuous DSN 34-meter antenna support from stations with visibility of the spacecraft for approximately 16 hours to 24 hours (dependent on the initial acquisition station) for launch and initial acquisition and continuous (24 hour) coverage for the early orbit phase (LEOP) in the following three weeks beginning on November 2.

During weeks 44 through 47, MRO is in the last 2 weeks of their Solar Conjunction phase and the beginning of their mapping phase in week 45, Rosetta is in their Mars

Swing-by phase throughout this period and SOHO, is in the beginning of their keyhole period requiring simultaneous passes utilizing the 26M subnet for uplink and the 34BWG1, 34HEF or 70M subnet for downlink support. *See the supporting data for Major Events and Major Downtime and view period overlap charts for Canberra, Goldstone and Madrid.*

The forecasted support for a SELENE launch on November 1, 2006 shows that the projected unsupportable time for launch and 3 weeks of early orbit support range from 4 to 44 percent. *See Figure 3.* The projected unsupportable time is due to the Moon view period overlap with the view periods of other prime missions and the high activities that are planned for MRO, Mars Express (MEX), ROSE, SOHO keyhole event during this period. *See Figure 5 in the attached supporting Data for the projected User unsupportable time for November 2006.* The November 6 time period is further impacted by the planned downtime for DSS-45. Therefore, it is highly recommended that SELENE not launch in November of 2006. *See Charts 1 and 2: View period overlap for November 2006 launch and early orbit phase.*

Figure 2: Projected Supportable Time Vs Unsustainable Time (in %)

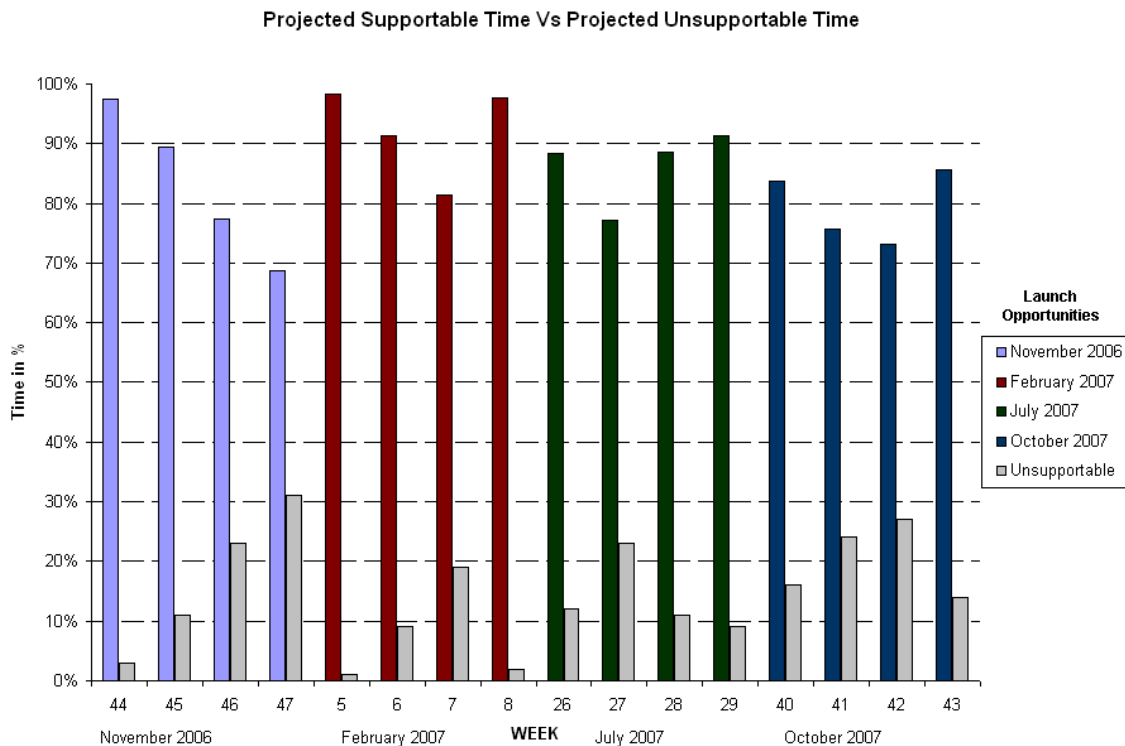
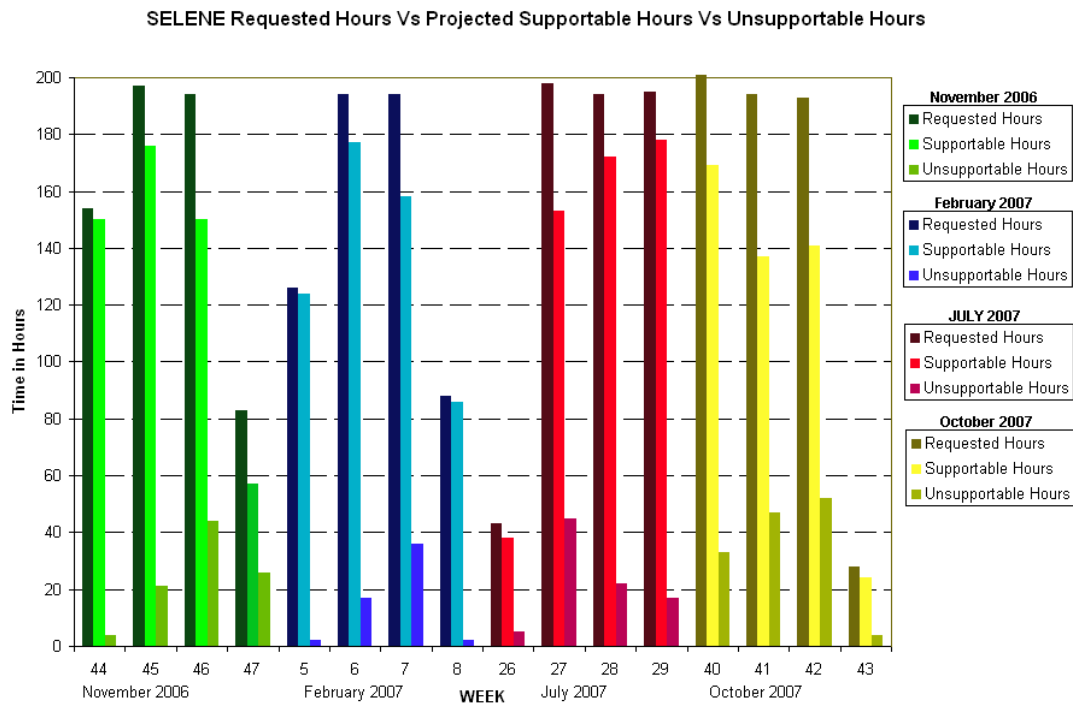


Figure 3: Requested Hours Vs Projected Supportable Hours Vs Projected Unsupportable Hours



February 1, 2007 Launch and Initial Acquisition

The proposed SELENE launch on February 1, 2007 is recommended although there are major activities occurring at this time for NHPC Jupiter Approach and ROSE Mars swing-by. NHPC and ROSE are requesting 70M and 34M support, their 70M support requirement may inadvertently impact SELENE by causing some Mars missions and other 70M Users to move to the 34M subnet. The analysis shows the projected unsupportable time for a February launch range from 1 to 18 percent. This is due to the Moon view period overlap with other prime missions at this time and the continued major events for MRO, MUSES-C (MUSC), and SOHO keyhole event. However, the February 1, 2007 launch is more favorable than the November 1, 2006 or October 1, 2007 launch periods. The overall projected supportable time for SELENE launching in February is from approximately 82 to 99 percent. The 1 to 18 percent lost time can be recovered by moving some SELENE support from the 34BWG1 subnet to the 34BWG2 and 34HEF subnets, in order to do this it would require SELENE to request Mars Global Surveyor (MGS) and Mars Odyssey (M01O) to MSPA (Multiple Spacecraft per Aperture) during conflict negotiation. *See figures 5 & 6: Canberra and Goldstone View Period overlap for February 1, 2007 launch in the attached supporting data.*

July 1, 2007 Launch and Initial Acquisition

The next favorable launch period for SELENE is July 1, 2007. Kepler's launch and commission scheduled for June 2007 have moved to October 1 through November 1 and the major activities for MSGR Venus approach and flyby and SOHO keyhole event will

have been completed. The remaining major activities occurring at this time that may affect SELENE receiving their requested support for launch and early orbit are MRO prime science requiring continuous or near continuous coverage continuing through the end of the year and the planned downtime for DSS-54 X/X Ka- Band installation. The projected unsupportable time for this launch period is approximately from 9 to 23 percent which can be eliminated by off-loading other missions from the 34BWG1 subnet to other antennas not requested by SELENE, using DSS-65 to replace DSS-54 and resolving conflicts through conflict negotiation. The analyses show that the July 1, 2007 time period is the next best opportunity to support a SELENE launch. *See the projected supportable versus unsupportable time for the proposed launch and early orbit dates in figure 2.*

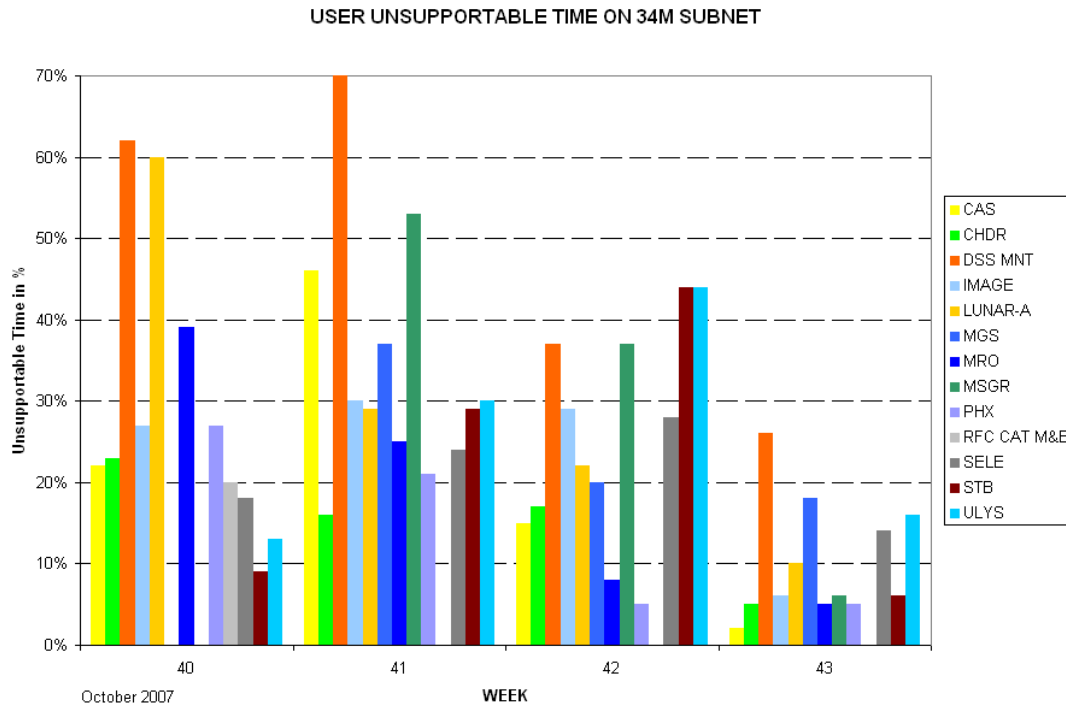
October 1, 2007 Launch and Initial Acquisition

The proposed SELENE launch date of October 1, 2007 is not recommended. The view periods for prime missions overlap with the Moon from 20 to 100 percent during this time period and is further compounded by the new launch and commissioning phase for Kepler occurring October 1 through November 1. There are numerous on-going major events for Cassini, MGS, MRO, Phoenix, STEREO Behind, NHPC, ROSE, and the SOHO keyhole event occurring at this time which will have a great impact on SELENE receiving their requested support for launch and early orbit support. The projected unsupportable time for SELENE launch and early orbit support on October 1 ranges from 14 to 24 percent. *See Projected Supportable Time Vs Unsuitable Time (in %) and the attached supporting data for Canberra and Goldstone view period overlap in figure 2.*

Conclusions

This support evaluation reviewed the four proposed launch opportunities and the requested 21 days of support for launch and early orbit. The projected supportable time for Launch and initial acquisition support for each launch opportunity range from approximately 68 to 99 percent. The projected supportable time is higher for the proposed launch in February and July of 2007 and considerably lower in November of 2006 and October of 2007. SELENE is projected to receive approximately 98 percent of their requested support for launch and initial acquisition on launch day and approximately 68 to 90 percent of their requested support for early orbit support in November 2006. The projected early orbit support in February 2007 is approximately 99 percent on launch day to 77 to 98 percent for LEOP, for July of 2007, the projected supportable time ranges from 98 percent on launch day to 77 to 91 percent for LEOP and for October 2007, the projected supportable time ranges from 84 percent on launch day to 73 to 85 percent for LEOP. Contention with other users of the DSN 34-meter resources is higher in November 2006 and October 2007 due to the high volume of major activities that are planned for each time period. Particular concern is noted during the proposed November 2006 and October 2007 launch opportunities where some users such as Chandra, MRO, MEX, MGS and Reference Frame Calibration, have previously reduced support to near health and safety levels and where actions to resolve contention on the 34 and 70-meter subnets remain uncertain. Prime mission unsupportable time range from 15 to 70 percent for November 2006 and October 2007. *See Figure 4 below and Figure 5 in the attached supporting data for November 1, 2006 launch.*

Figure 4: 34BWG1 Projected Unsupportable Time (in %) for October 2007



The results from adding SELENE launch and early orbit requirements into the November 2006 or October 2007 time period strongly shows that the launch should be moved to another time period. It is estimated that a move beyond 2006 weeks 44 - 47 to either 2007 weeks 5 - 8 or weeks 27 - 30 would be better. Analyses shows that contention on DSN resources from February 2007, weeks 5 through 8 and July 2007, weeks 27 through 30 is low; moving the SELENE launch inside either of these periods would assure 77 to 98% supportability. See Figure 3: 34BWG1 Projected Supportable Time Vs Projected Unsupportable Time (in %)

As always, the results of this evaluation are preliminary in that the network load changes as requirements for planned missions are input and updated.

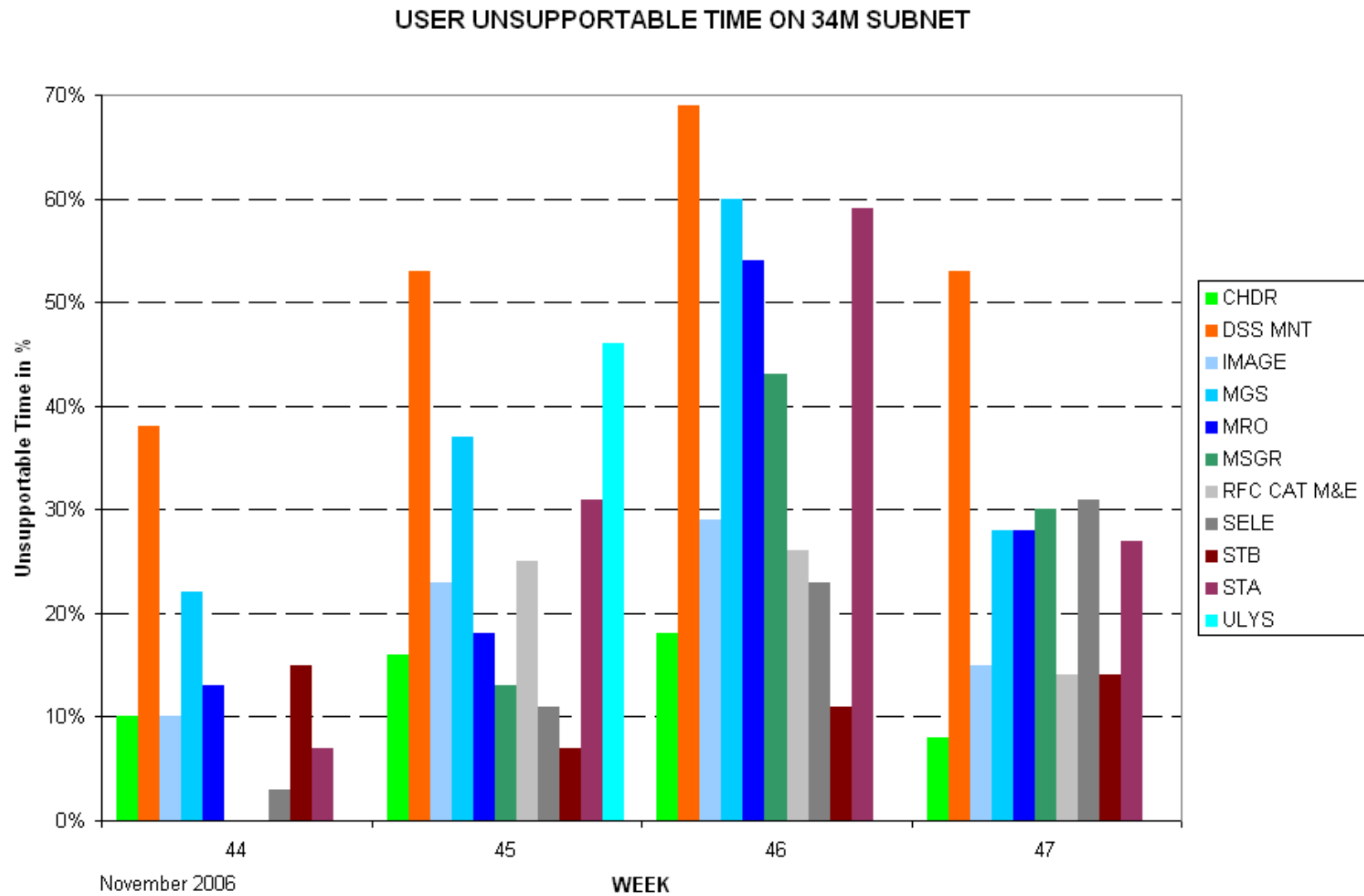
Attachment:

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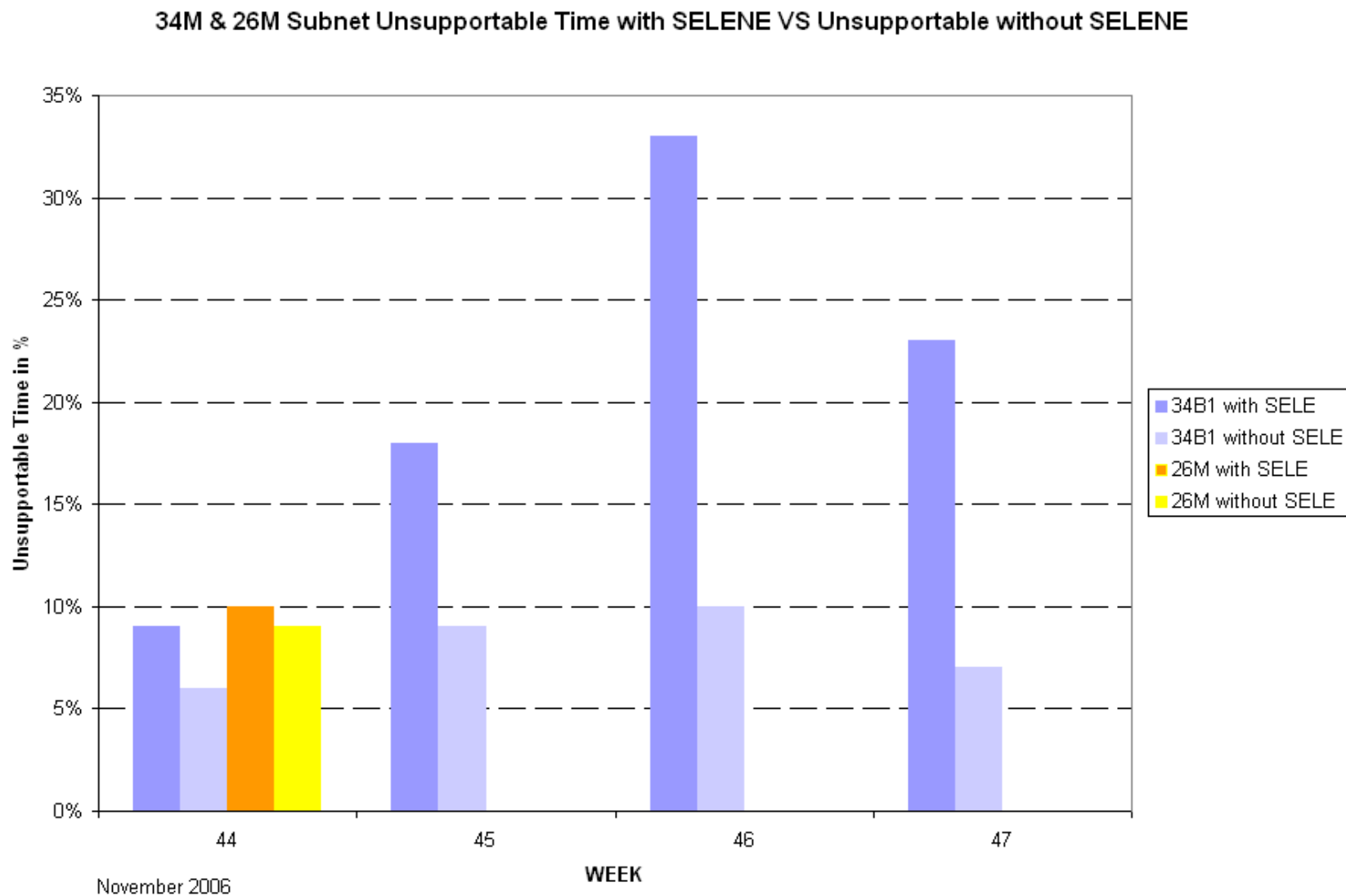
Supporting Data

Figure 5: 34M Subnet Projected User Unsupportable Time



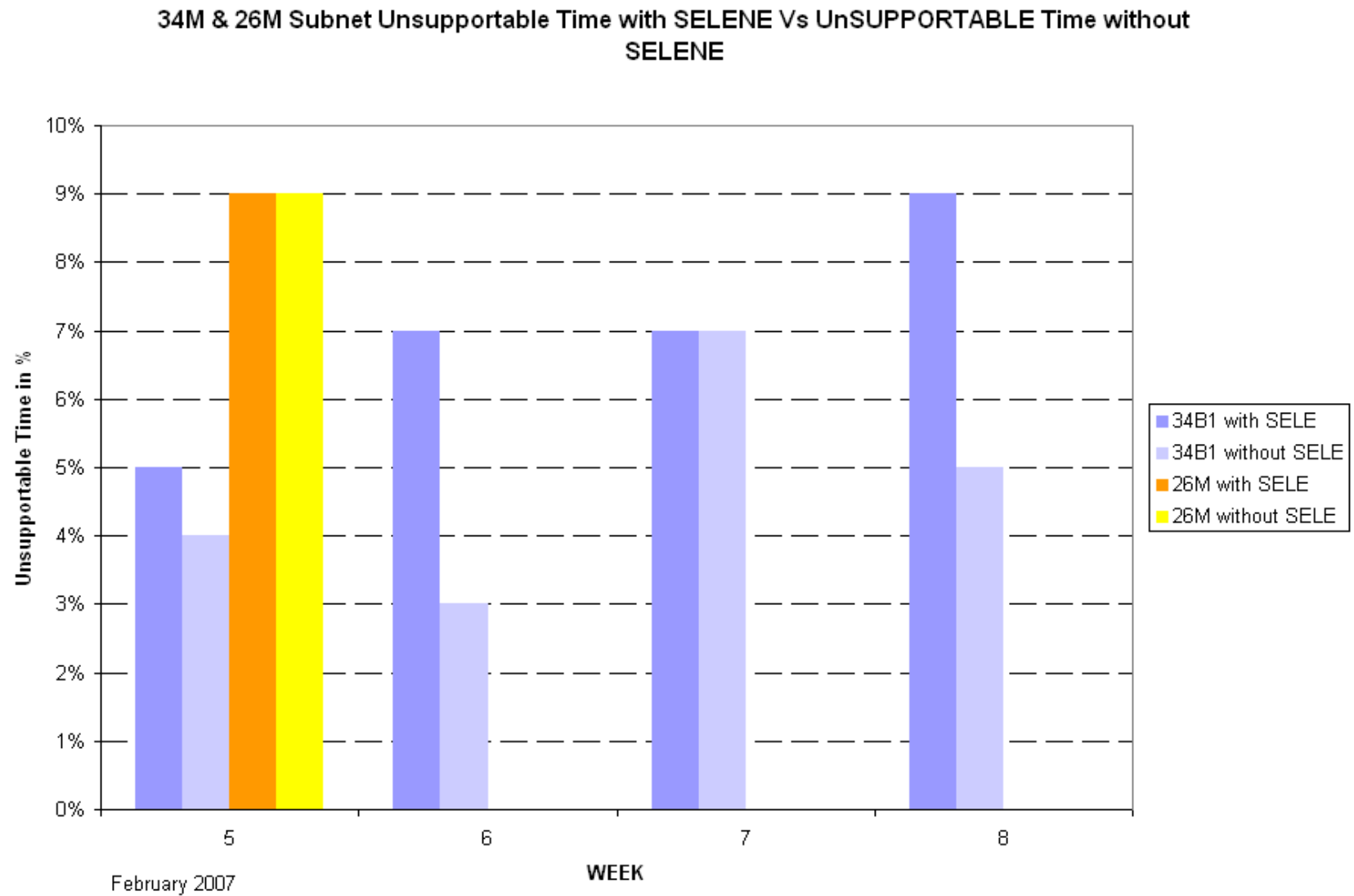
Supporting Data

Figures 6: 34M & 26M Subnet Projected Unsupportable Time with SELENE Vs Projected Unsupportable Time without SELENE for November 2006



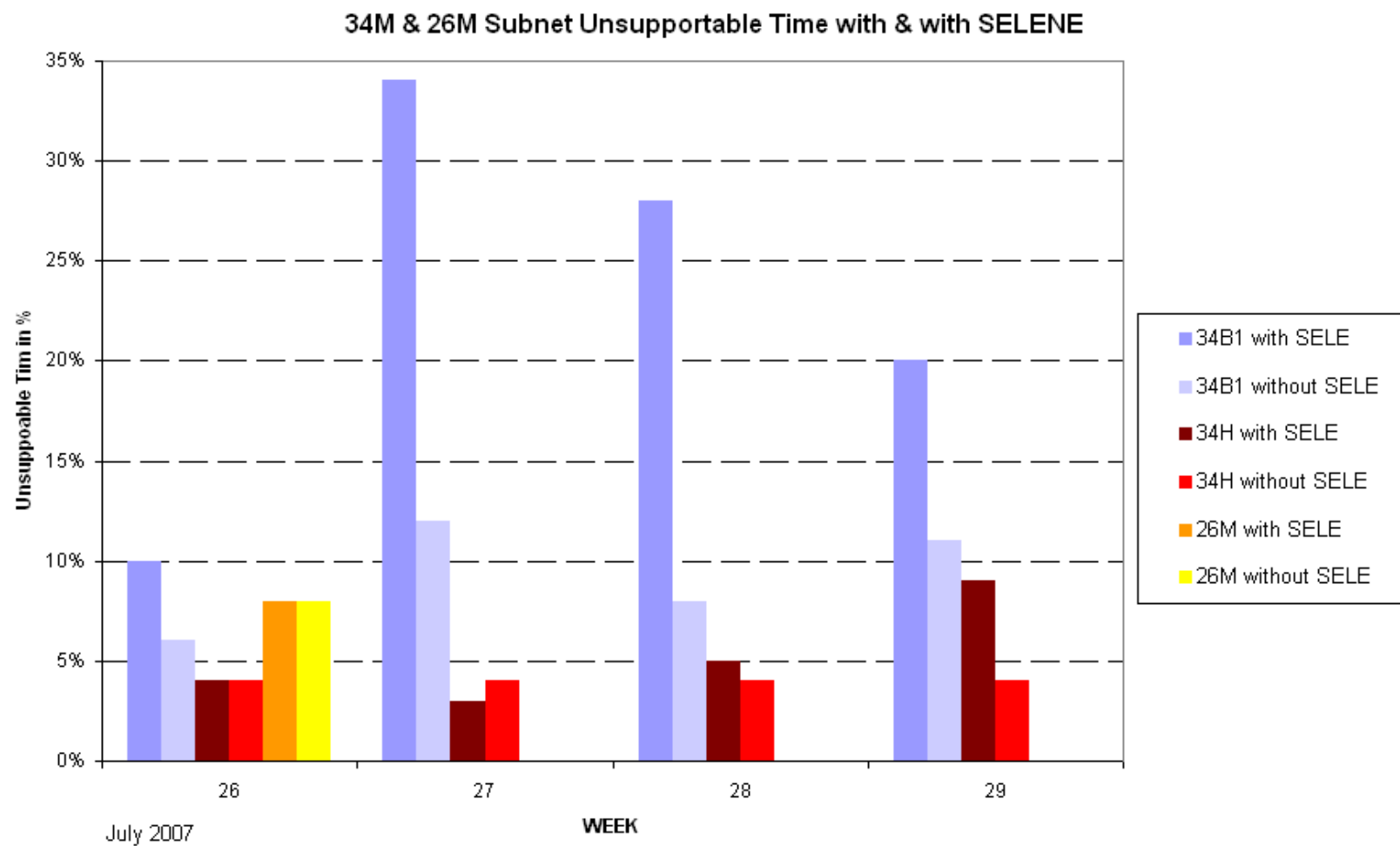
Supporting Data

Figures 7: 34M & 26M Subnet Projected Unsupportable Time with SELENE Vs Projected Unsupportable Time without SELENE for February 2007



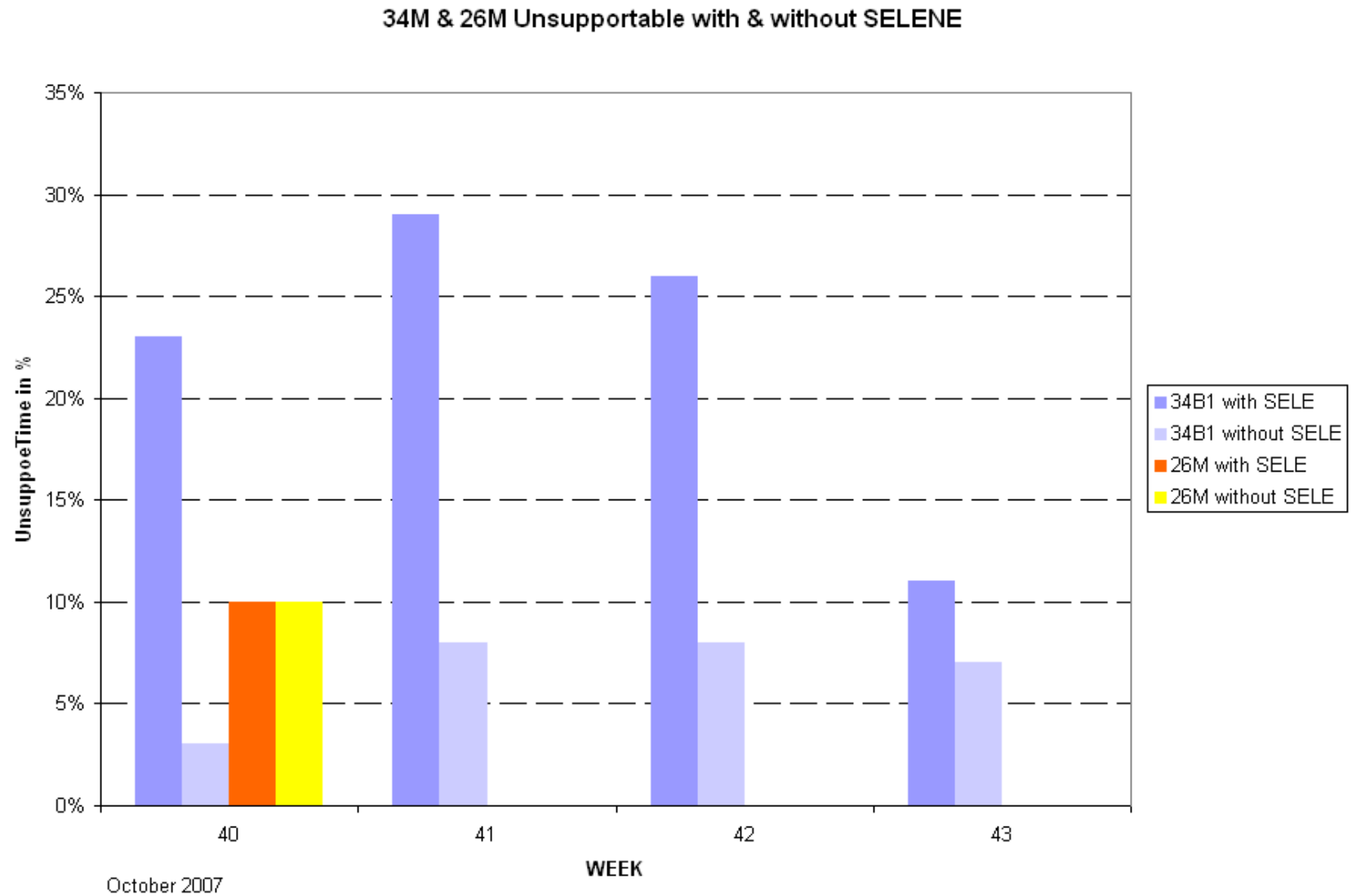
Supporting Data

Figures 8: 34M & 26M Subnet Projected Unsupportable Time with SELENE Vs Projected Unsupportable Time without SELENE for July 2007



Supporting Data

Figures 9: 34M & 26M Subnet Projected Unsupportable Time with SELENE Vs Projected Unsupportable Time without SELENE for October 2007



Supporting Data

Chart 1: Moon View Period Overlap at Canberra for November 2006

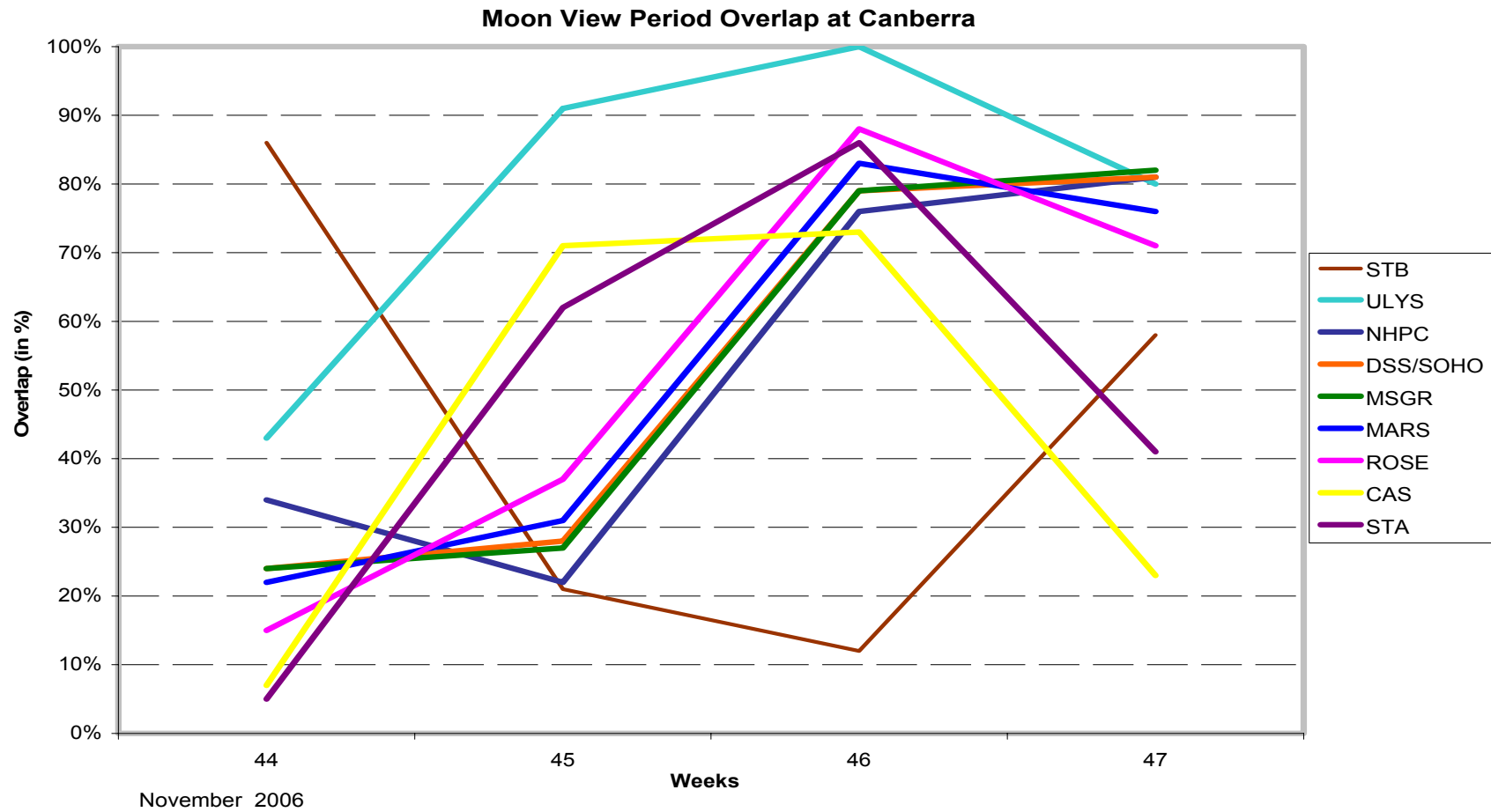
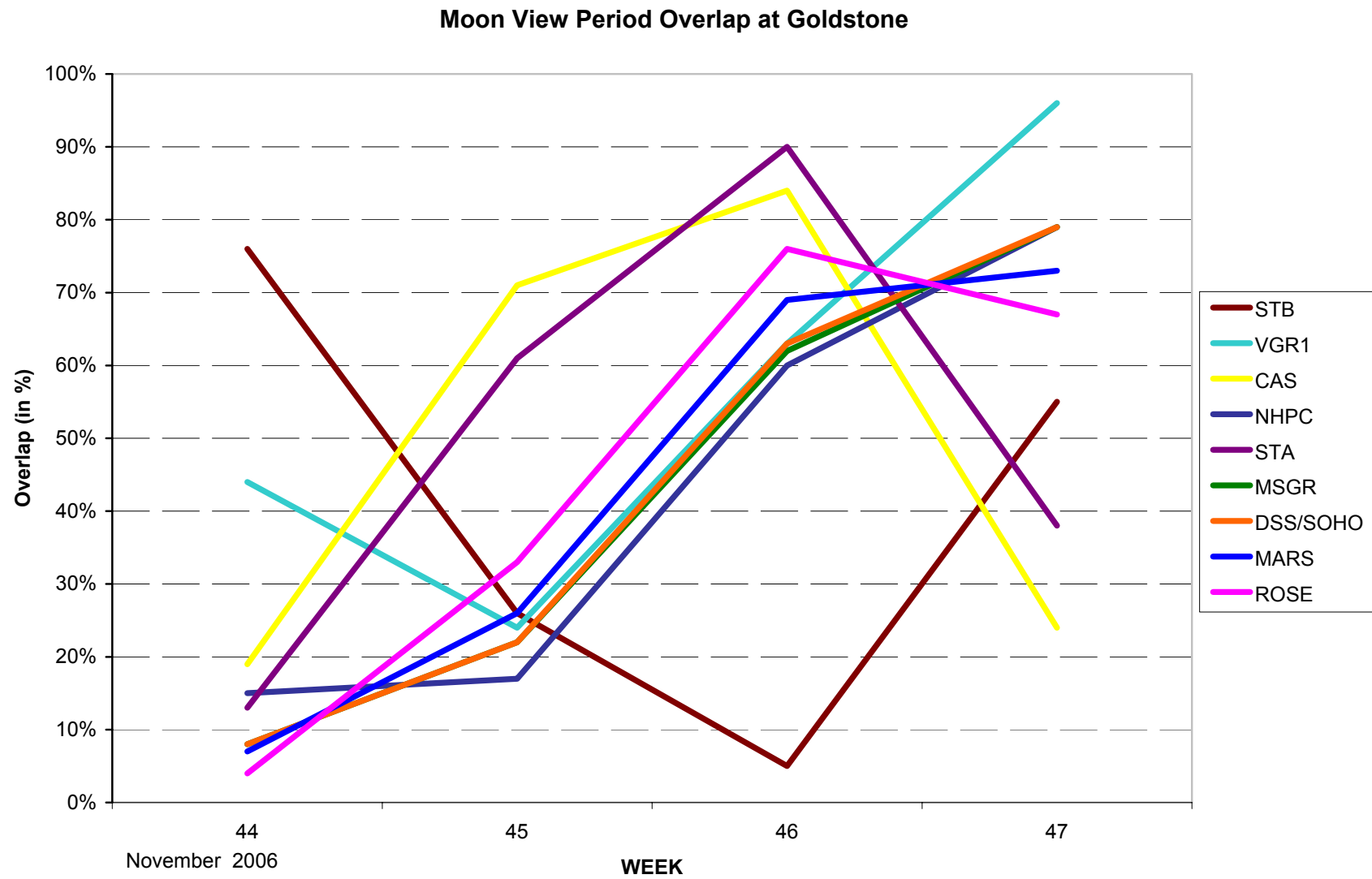
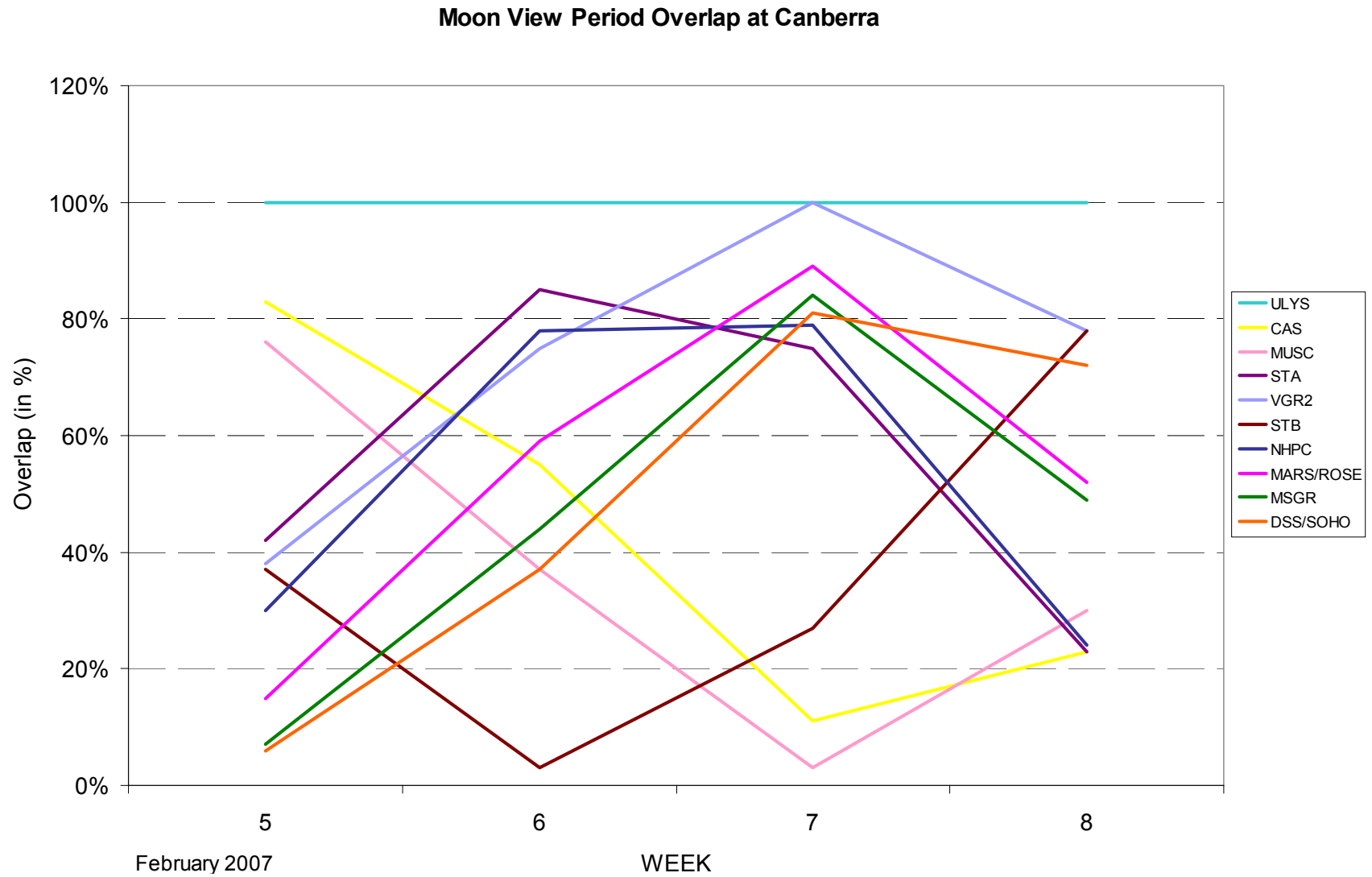


Chart 2: Moon View Period Overlap at Goldstone for November 2006



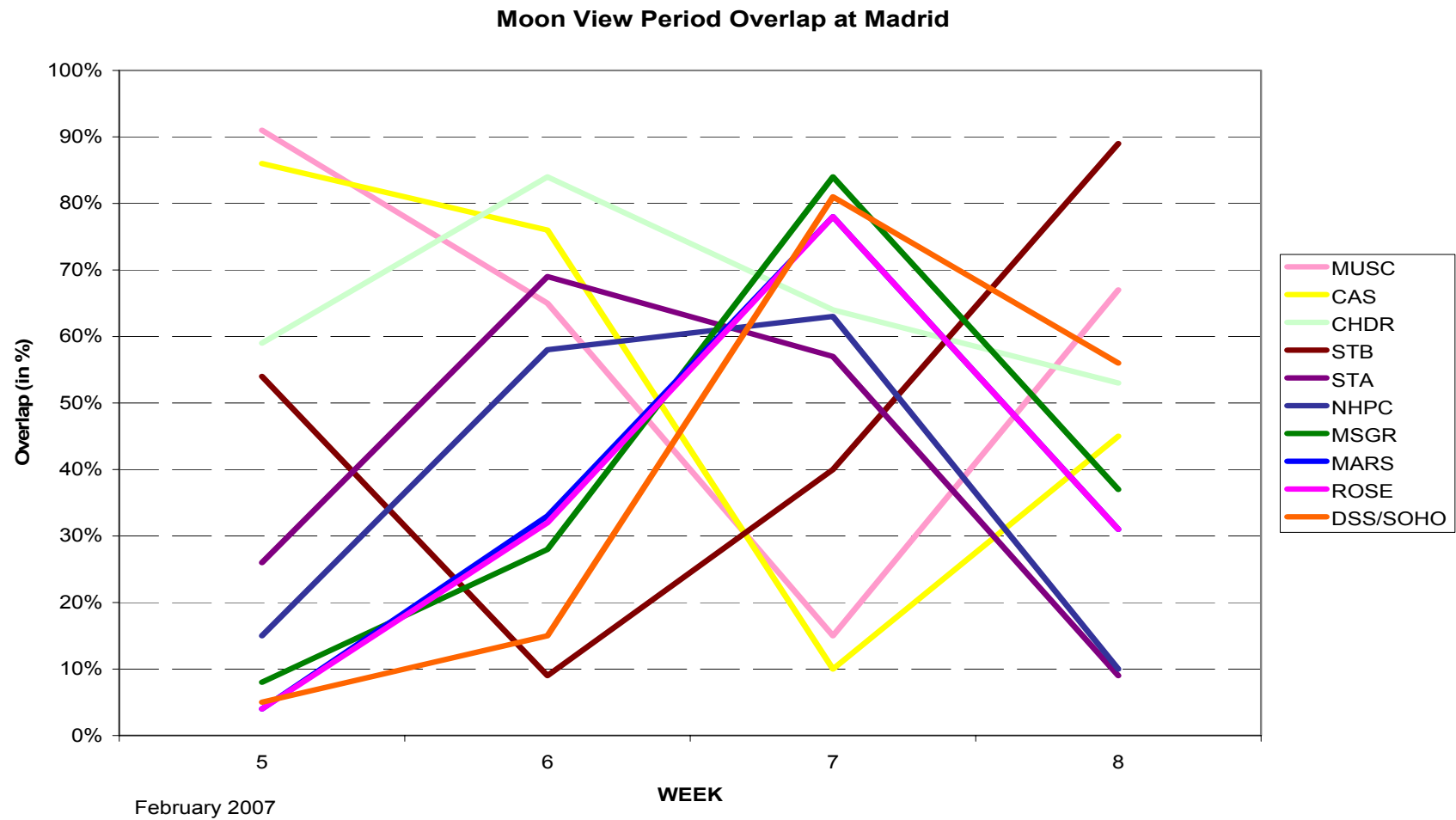
Supporting Data

Chart 3: Moon View Period Overlap at Canberra for February 2007



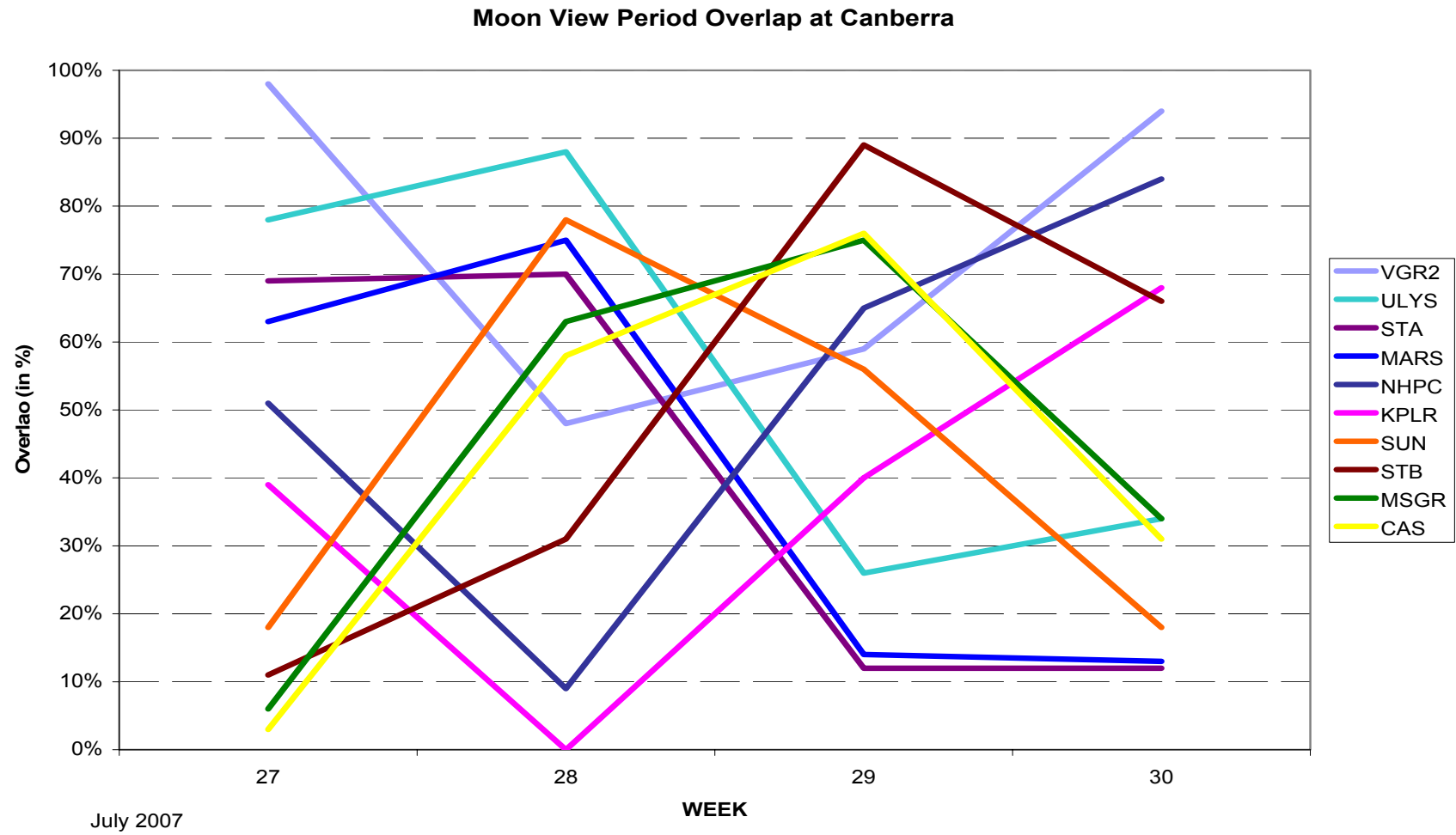
Supporting Data

Chart 4: Moon View Period Overlap at Madrid for February 2007



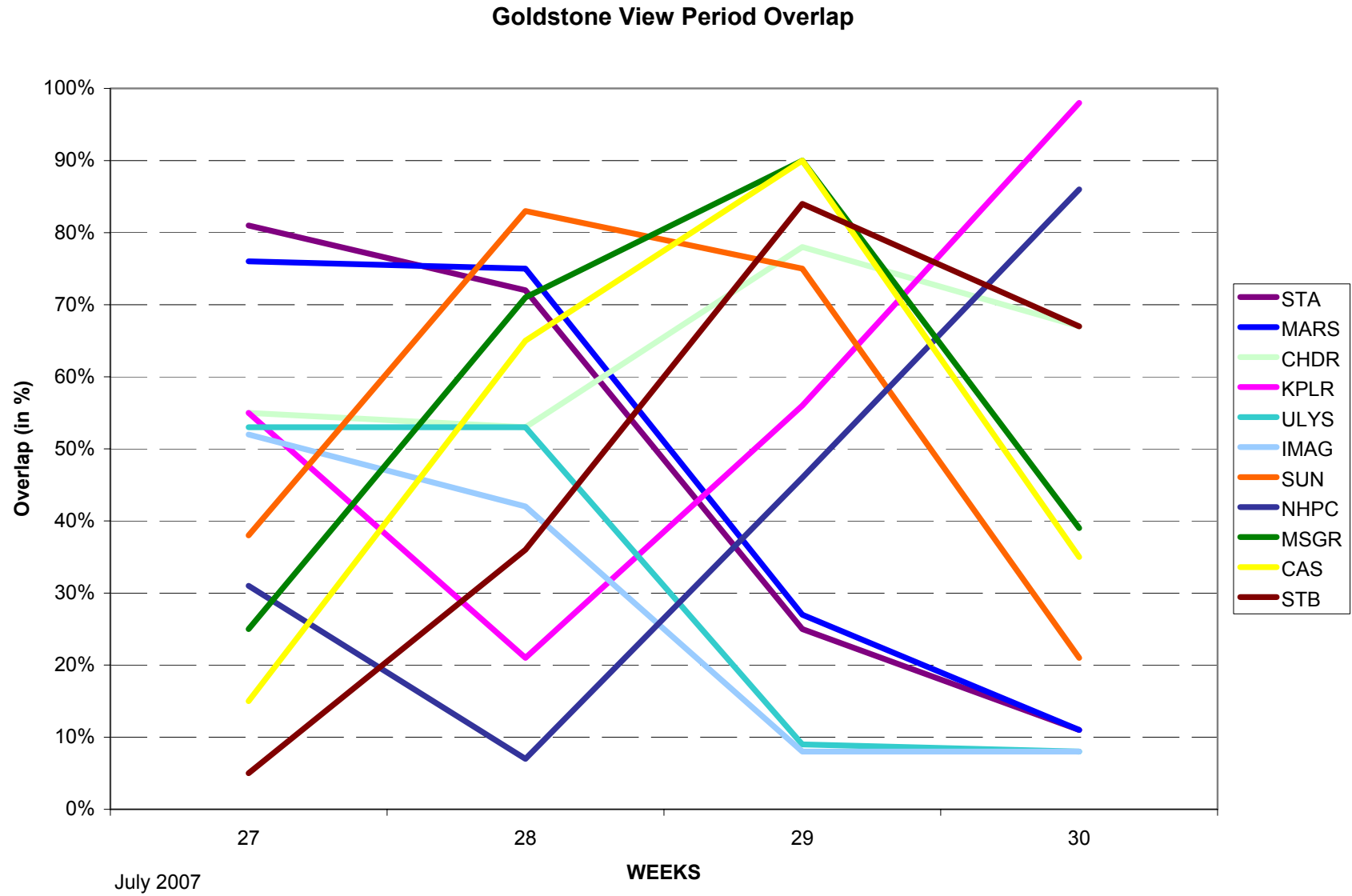
Supporting Data

Chart 5: Moon View Period Overlap at Canberra for July 2007



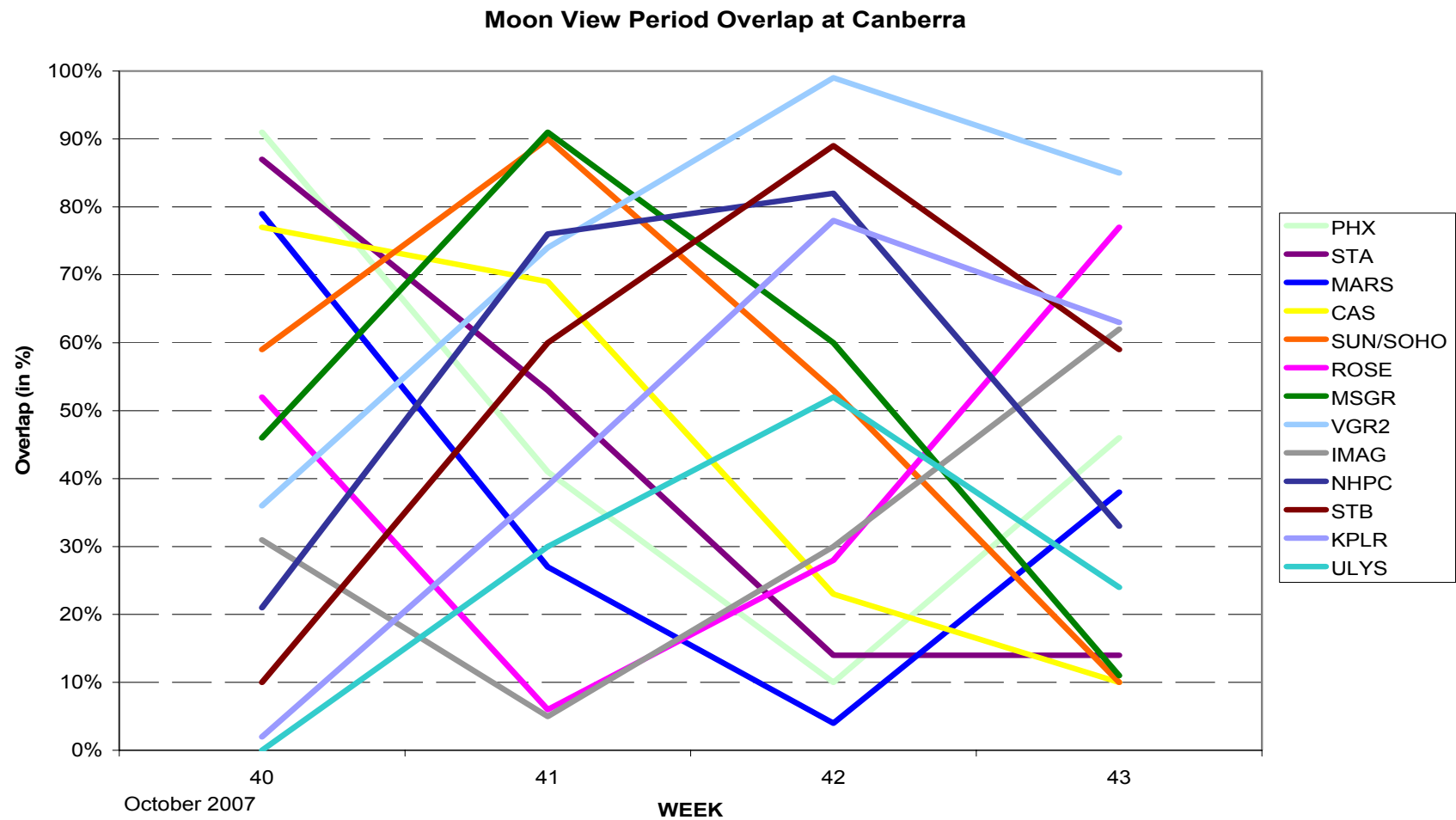
Supporting Data

Chart 6: Moon View Period Overlap at Goldstone for July 2007



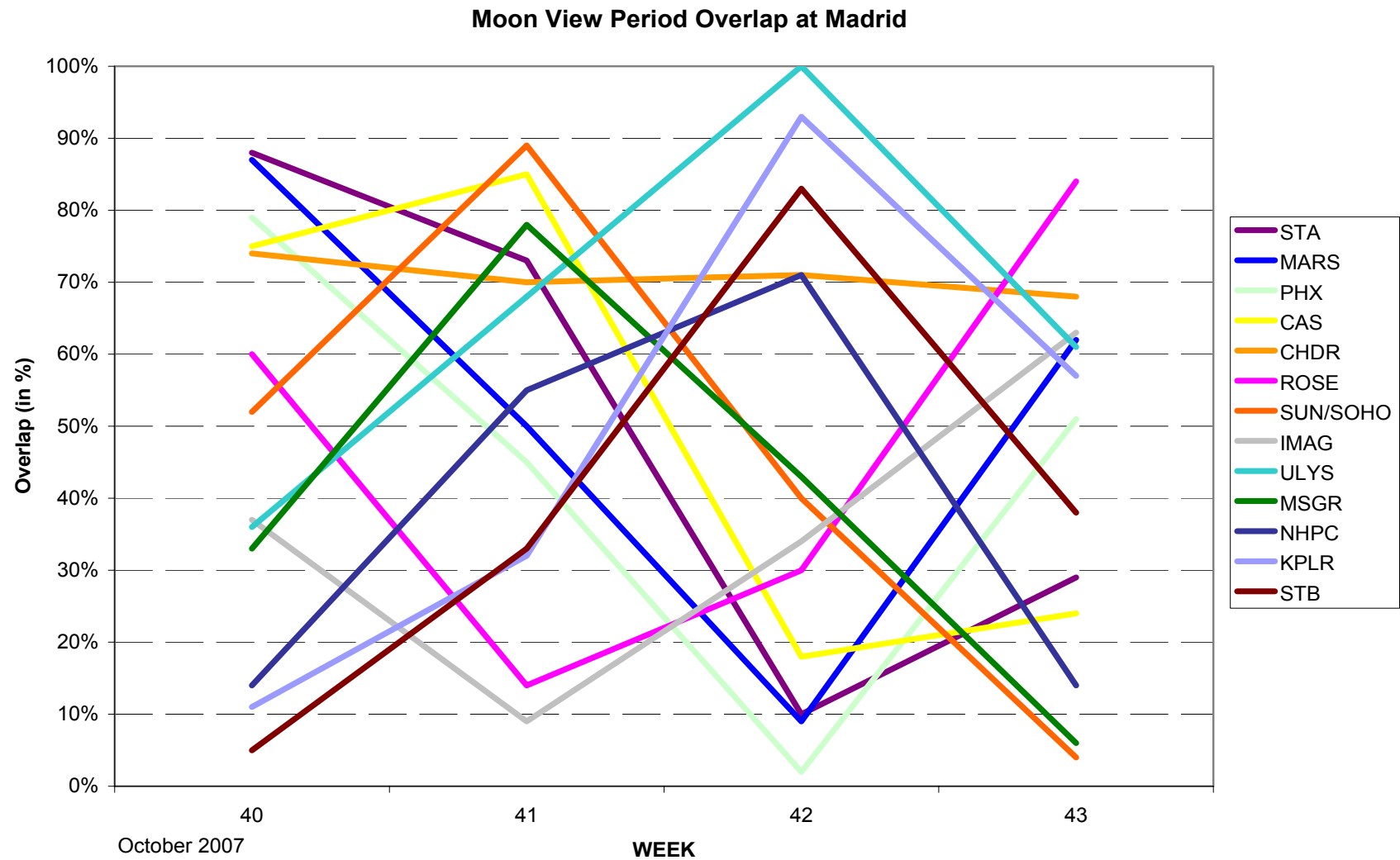
Supporting Data

Chart 7: Moon View Period Overlap at Canberra for October 2007



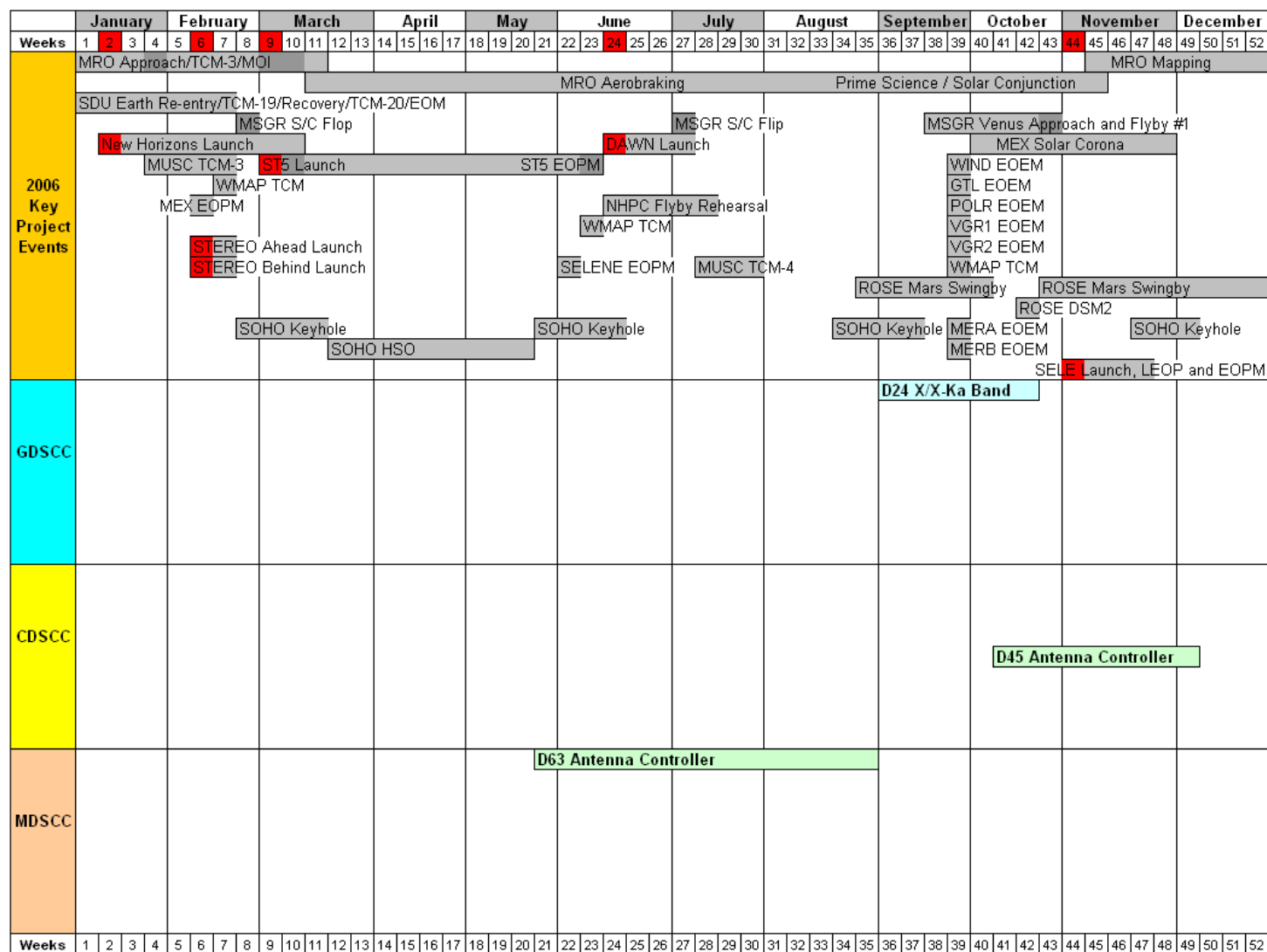
Supporting Data

Chart 8: Moon View Period Overlap at Madrid for October 2007



Supporting Data

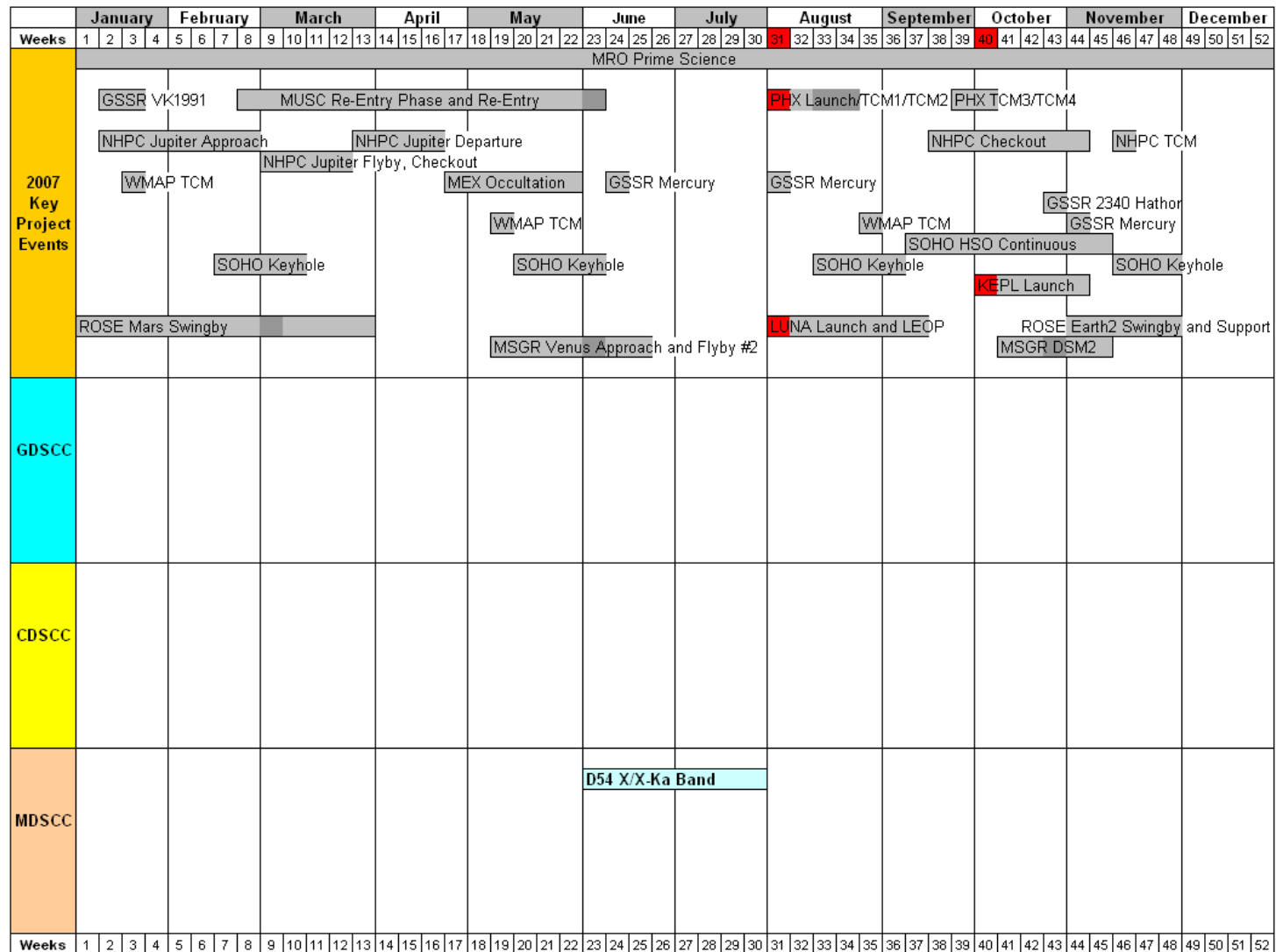
Chart 9: Planned 2006 Major Events and Antenna Downtime



Revised: November 17, 2004

Supporting Data

Chart 10: Planned 2007 Major Events and Antenna Downtime



Revised: November 17, 2004